



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 08:13 AM UTC

PDB ID : 1WP9 / pdb\_00001wp9  
Title : Crystal structure of Pyrococcus furiosus Hef helicase domain  
Authors : Nishino, T.; Komori, K.; Tsuchiya, D.; Ishino, Y.; Morikawa, K.  
Deposited on : 2004-08-31  
Resolution : 2.90 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto:validation@mail.wwpdb.org)

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

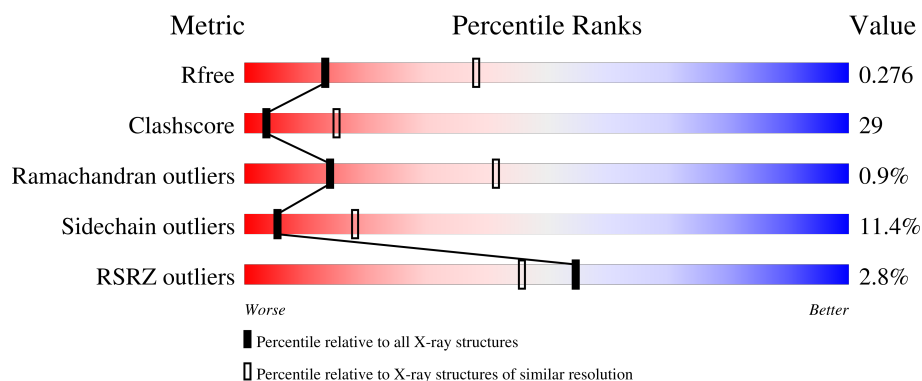
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.90 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	180053	2481 (2.90-2.90)
Clashscore	190562	2690 (2.90-2.90)
Ramachandran outliers	187476	2623 (2.90-2.90)
Sidechain outliers	187428	2625 (2.90-2.90)
RSRZ outliers	180081	2481 (2.90-2.90)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions  $\leq 5\%$ . The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	494	<div> <div>4%</div> <div>49% 39% 9%</div> </div>
1	B	494	<div> <div>3%</div> <div>48% 40% 7%</div> </div>
1	C	494	<div> <div>4%</div> <div>44% 43% 9%</div> </div>
1	D	494	<div> <div>3%</div> <div>47% 40% 7% 5%</div> </div>
1	E	494	<div> <div>0%</div> <div>46% 43% 7%</div> </div>

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Mol	Chain	Length	Quality of chain
1	F	494	<div> <div></div> <div>%</div> <div>45%</div> <div>43%</div> <div>8%</div> <div>.</div> </div>

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	PO4	A	495	-	-	X	-
2	PO4	C	495	-	-	X	-

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 22913 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called ATP-dependent RNA helicase, putative.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	479	Total	C	N	O	S	0	0	0
			3831	2445	683	689	14			
1	B	477	Total	C	N	O	S	0	0	0
			3817	2436	680	687	14			
1	C	475	Total	C	N	O	S	0	0	0
			3807	2431	678	684	14			
1	D	469	Total	C	N	O	S	0	0	0
			3765	2407	670	674	14			
1	E	475	Total	C	N	O	S	0	0	0
			3807	2431	678	684	14			
1	F	475	Total	C	N	O	S	0	0	0
			3807	2431	678	684	14			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	2	VAL	LEU	engineered mutation	UNP Q8TZH8
B	2	VAL	LEU	engineered mutation	UNP Q8TZH8
C	2	VAL	LEU	engineered mutation	UNP Q8TZH8
D	2	VAL	LEU	engineered mutation	UNP Q8TZH8
E	2	VAL	LEU	engineered mutation	UNP Q8TZH8
F	2	VAL	LEU	engineered mutation	UNP Q8TZH8

- Molecule 2 is PHOSPHATE ION (CCD ID: PO4) (formula: O<sub>4</sub>P).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	O	P	0	0
			5	4	1		
2	B	1	Total	O	P	0	0
			5	4	1		
2	C	1	Total	O	P	0	0
			5	4	1		
2	D	1	Total	O	P	0	0
			5	4	1		
2	E	1	Total	O	P	0	0
			5	4	1		
2	F	1	Total	O	P	0	0
			5	4	1		

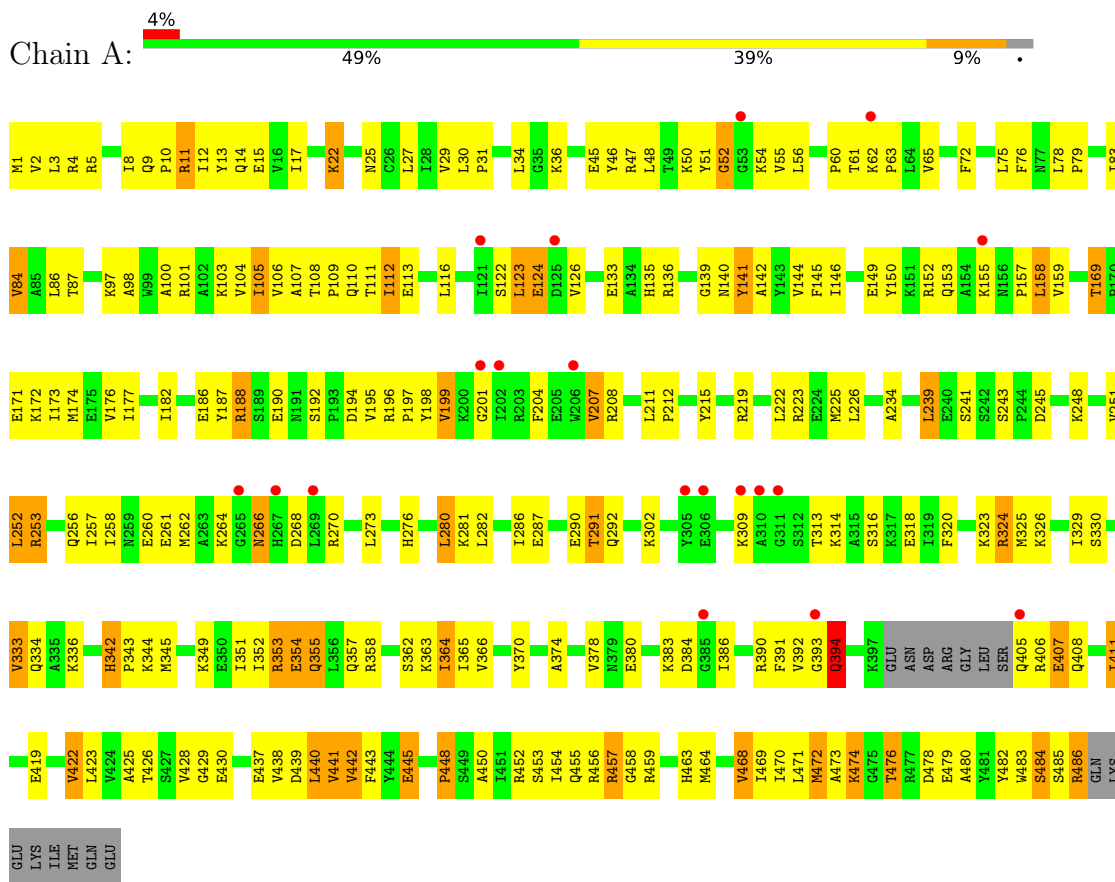
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	4	Total	O	0	0
			4	4		
3	B	13	Total	O	0	0
			13	13		
3	C	8	Total	O	0	0
			8	8		
3	D	7	Total	O	0	0
			7	7		
3	E	13	Total	O	0	0
			13	13		
3	F	4	Total	O	0	0
			4	4		

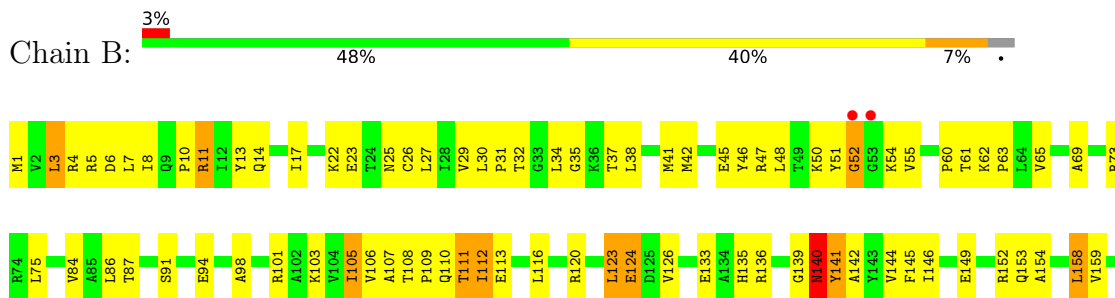
### 3 Residue-property plots

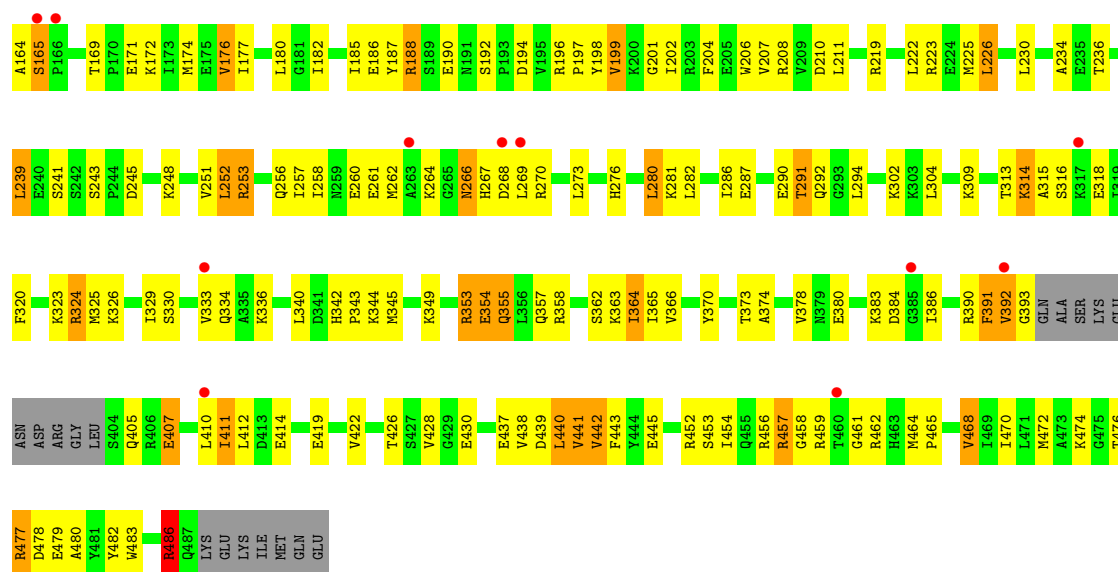
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ( $RSRZ > 2$ ). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: ATP-dependent RNA helicase, putative

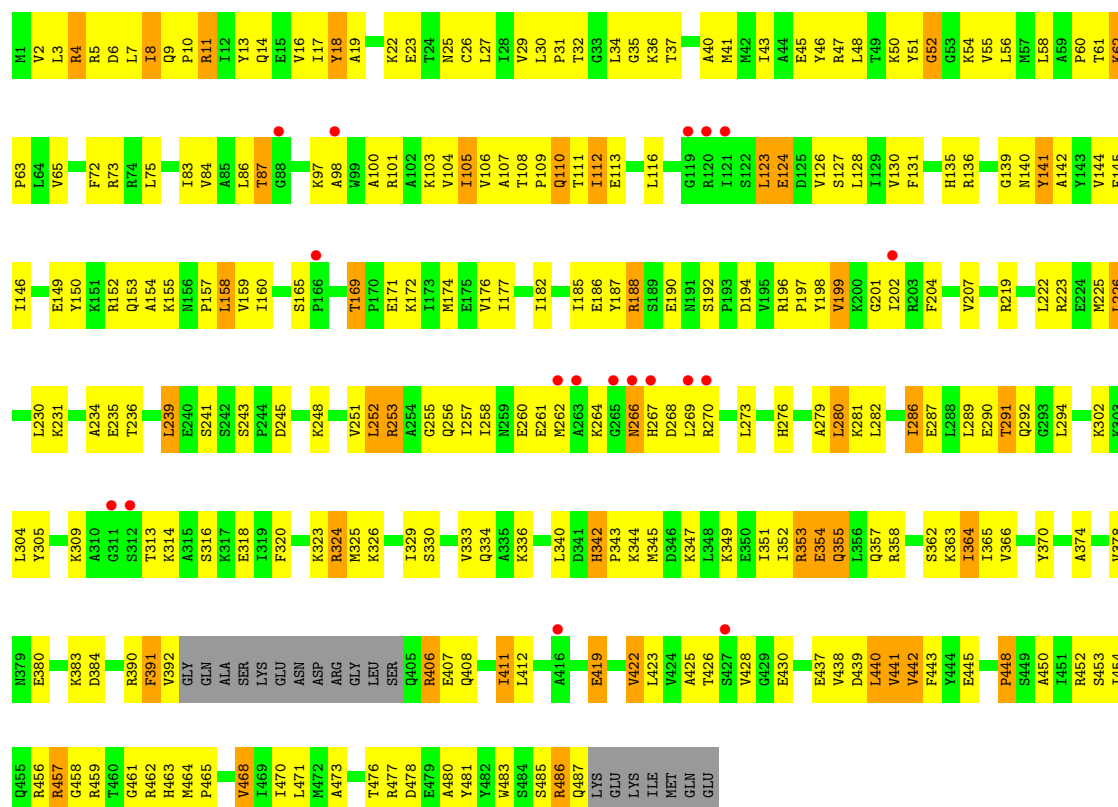
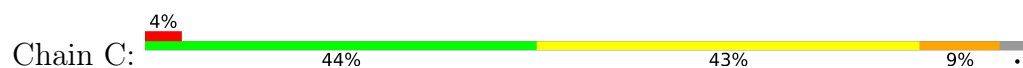


- Molecule 1: ATP-dependent RNA helicase, putative



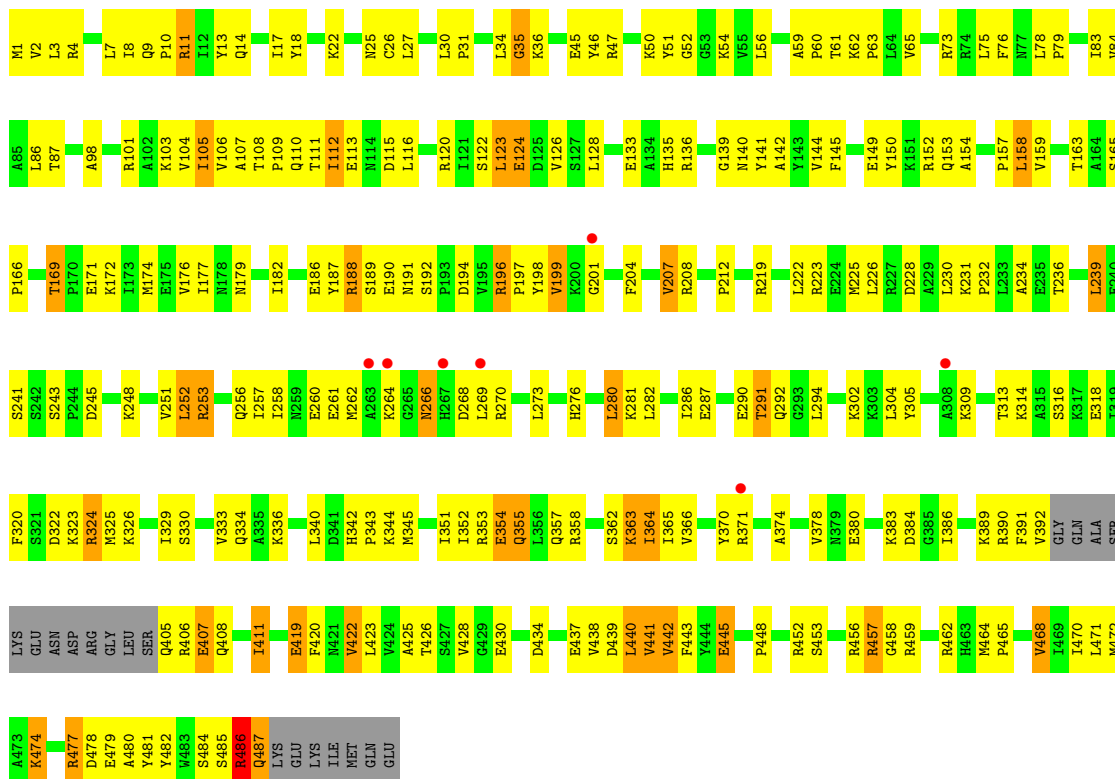


- Molecule 1: ATP-dependent RNA helicase, putative



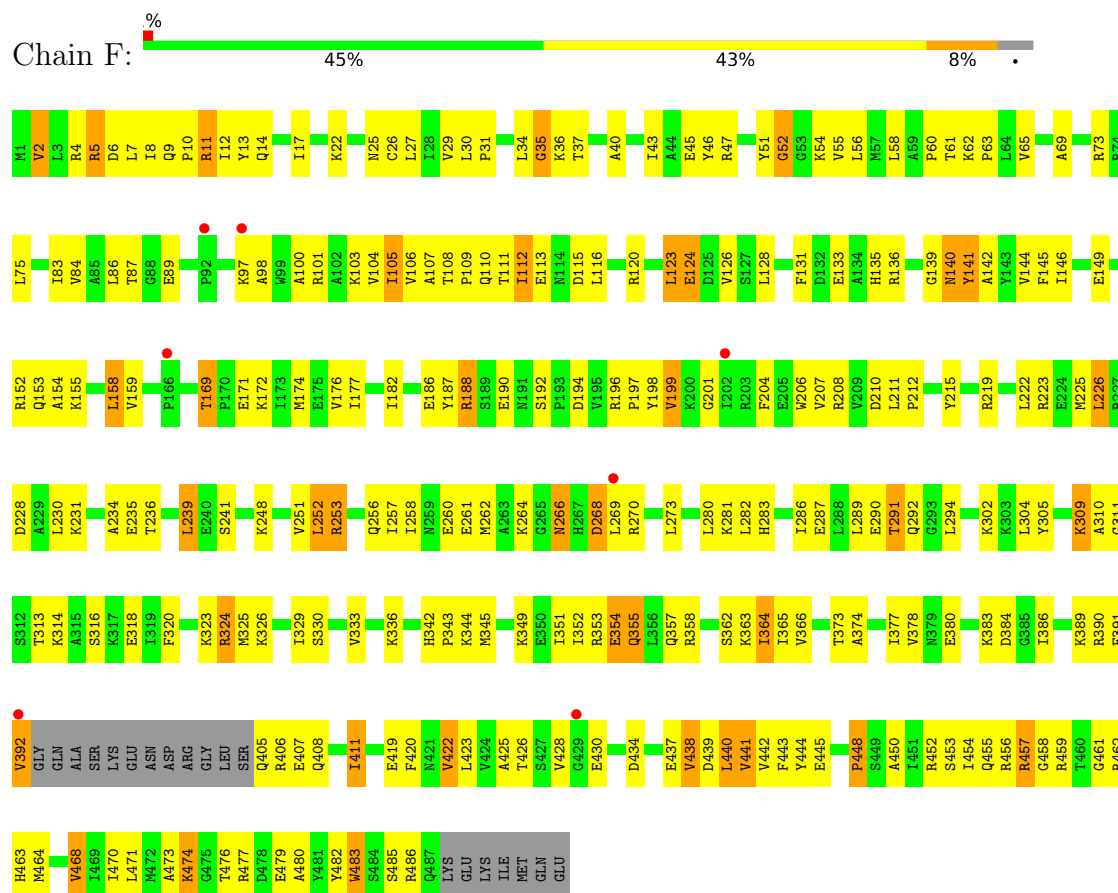
- Molecule 1: ATP-dependent RNA helicase, putative







● Molecule 1: ATP-dependent RNA helicase, putative



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	118.50Å 165.94Å 119.16Å 90.00° 114.85° 90.00°	Depositor
Resolution (Å)	15.00 – 2.90 15.00 – 2.90	Depositor EDS
% Data completeness (in resolution range)	97.1 (15.00-2.90) 96.4 (15.00-2.90)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.87 (at 2.76Å)	Xtriage
Refinement program	CNS	Depositor
R, $R_{free}$	0.257 , 0.286 0.249 , 0.276	Depositor DCC
$R_{free}$ test set	9383 reflections (9.05%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	64.9	Xtriage
Anisotropy	0.179	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.29 , 46.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.014 for l,-k,h	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	22913	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	63.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.46% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

## 5 Model quality

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: PO4

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 5$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z  > 5$	RMSZ	$\# Z  > 5$
1	A	0.57	0/3894	1.00	14/5241 (0.3%)
1	B	0.57	0/3880	1.02	17/5223 (0.3%)
1	C	0.54	0/3870	1.01	13/5210 (0.2%)
1	D	0.52	0/3827	0.99	11/5150 (0.2%)
1	E	0.55	0/3870	1.02	16/5210 (0.3%)
1	F	0.52	0/3870	1.01	14/5210 (0.3%)
All	All	0.55	0/23211	1.01	85/31244 (0.3%)

There are no bond length outliers.

The worst 5 of 85 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	120	ARG	NE-CZ-NH2	7.60	126.04	119.20
1	E	439	ASP	N-CA-C	7.48	119.43	111.28
1	C	35	GLY	N-CA-C	7.39	125.57	115.30
1	E	196	ARG	NE-CZ-NH2	7.28	125.75	119.20
1	A	439	ASP	N-CA-C	7.24	119.17	111.28

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3831	0	4023	244	0
1	B	3817	0	4005	227	1
1	C	3807	0	3997	252	0
1	D	3765	0	3956	242	0
1	E	3807	0	3997	235	1
1	F	3807	0	3997	250	0
2	A	5	0	0	5	0
2	B	5	0	0	1	0
2	C	5	0	0	2	0
2	D	5	0	0	0	0
2	E	5	0	0	1	0
2	F	5	0	0	1	0
3	A	4	0	0	0	0
3	B	13	0	0	0	0
3	C	8	0	0	0	0
3	D	7	0	0	2	0
3	E	13	0	0	0	0
3	F	4	0	0	0	0
All	All	22913	0	23975	1372	1

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 29.

The worst 5 of 1372 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:F:211:LEU:H	1:F:474:LYS:HE2	1.19	1.06
1:E:405:GLN:HB2	1:E:408:GLN:HG3	1.38	1.00
1:D:123:LEU:HD23	1:D:123:LEU:H	1.25	1.00
1:A:174:MET:HE3	1:E:480:ALA:HB2	1.43	0.98
1:E:426:THR:HG23	1:E:428:VAL:HG12	1.47	0.97

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:268:ASP:OD2	1:E:371:ARG:NH1[1_455]	2.08	0.12

## 5.3 Torsion angles ⓘ

### 5.3.1 Protein backbone ⓘ

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	475/494 (96%)	442 (93%)	28 (6%)	5 (1%)	11	36
1	B	473/494 (96%)	443 (94%)	26 (6%)	4 (1%)	16	44
1	C	471/494 (95%)	435 (92%)	29 (6%)	7 (2%)	8	28
1	D	463/494 (94%)	433 (94%)	26 (6%)	4 (1%)	14	41
1	E	471/494 (95%)	441 (94%)	27 (6%)	3 (1%)	21	51
1	F	471/494 (95%)	439 (93%)	29 (6%)	3 (1%)	21	51
All	All	2824/2964 (95%)	2633 (93%)	165 (6%)	26 (1%)	14	41

5 of 26 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	52	GLY
1	C	52	GLY
1	F	52	GLY
1	A	52	GLY
1	A	484	SER

### 5.3.2 Protein sidechains ⓘ

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	413/427 (97%)	364 (88%)	49 (12%)	5	16
1	B	412/427 (96%)	367 (89%)	45 (11%)	6	20
1	C	411/427 (96%)	362 (88%)	49 (12%)	5	16

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	D	406/427 (95%)	361 (89%)	45 (11%)	6	20
1	E	411/427 (96%)	363 (88%)	48 (12%)	5	17
1	F	411/427 (96%)	365 (89%)	46 (11%)	6	19
All	All	2464/2562 (96%)	2182 (89%)	282 (11%)	5	18

5 of 282 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	468	VAL
1	F	11	ARG
1	F	314	LYS
1	C	18	TYR
1	C	7	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 103 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	179	ASN
1	E	140	ASN
1	F	369	ASN
1	D	259	ASN
1	D	463	HIS

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

## 5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

## 5.6 Ligand geometry

6 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z  > 2$	Counts	RMSZ	$\# Z  > 2$
2	PO4	D	495	-	4,4,4	1.67	0	6,6,6	0.44	0
2	PO4	E	495	-	4,4,4	1.71	0	6,6,6	0.46	0
2	PO4	C	495	-	4,4,4	1.74	1 (25%)	6,6,6	0.50	0
2	PO4	B	495	-	4,4,4	1.72	1 (25%)	6,6,6	0.46	0
2	PO4	A	495	-	4,4,4	1.91	3 (75%)	6,6,6	0.44	0
2	PO4	F	495	-	4,4,4	1.66	0	6,6,6	0.45	0

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	495	PO4	P-O4	-2.26	1.48	1.54
2	C	495	PO4	P-O3	-2.24	1.48	1.54
2	A	495	PO4	P-O3	-2.14	1.48	1.54
2	A	495	PO4	P-O2	-2.13	1.48	1.54
2	B	495	PO4	P-O4	-2.05	1.48	1.54

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	E	495	PO4	1	0
2	C	495	PO4	2	0
2	B	495	PO4	1	0
2	A	495	PO4	5	0
2	F	495	PO4	1	0

## 5.7 Other polymers

There are no such residues in this entry.

## 5.8 Polymer linkage issues

There are no chain breaks in this entry.



## 6 Fit of model and data [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95<sup>th</sup> percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å <sup>2</sup> )	Q<0.9
1	A	479/494 (96%)	0.13	19 (3%) 42 34	24, 55, 97, 109	0
1	B	477/494 (96%)	0.03	13 (2%) 56 47	24, 57, 95, 117	0
1	C	475/494 (96%)	0.19	18 (3%) 44 36	30, 62, 99, 119	0
1	D	469/494 (94%)	0.18	17 (3%) 46 38	30, 67, 100, 116	0
1	E	475/494 (96%)	0.05	7 (1%) 72 64	25, 58, 99, 118	0
1	F	475/494 (96%)	0.17	7 (1%) 72 64	35, 65, 102, 126	0
All	All	2850/2964 (96%)	0.13	81 (2%) 55 46	24, 61, 99, 126	0

The worst 5 of 81 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	269	LEU	6.4
1	C	120	ARG	4.4
1	D	461	GLY	4.2
1	B	269	LEU	4.0
1	C	262	MET	3.5

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

### 6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

## 6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
2	PO4	F	495	5/5	0.76	0.16	118,118,119,119	0
2	PO4	D	495	5/5	0.79	0.17	124,125,125,126	0
2	PO4	C	495	5/5	0.82	0.17	84,86,88,88	0
2	PO4	E	495	5/5	0.83	0.20	111,112,112,113	0
2	PO4	A	495	5/5	0.86	0.17	97,98,98,99	0
2	PO4	B	495	5/5	0.88	0.21	105,105,106,107	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.